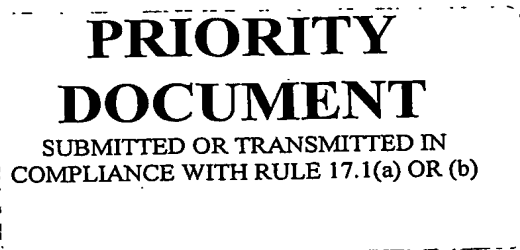
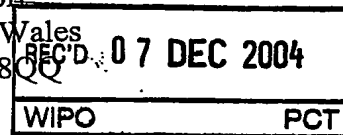




INVESTOR IN PEOPLE



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Newport
South Wales
NP10 8QQ

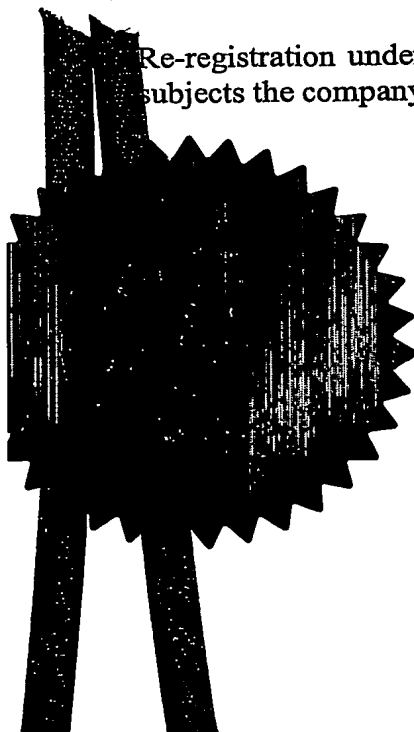



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In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

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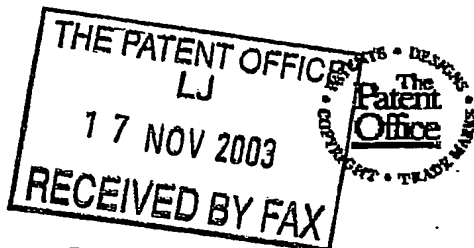
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Signed 

Dated 15 November 2004

Patents Form 1/77

Patents Act 1977
(Rule 16)17NOV03 E852760-1 D10153
P01/7700 0.00-0326721.8

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference

P177-GB

2. Patent application number

(The Patent Office will fill in this part)

17 NOV 2003

0326721.8

3. Full name, address and postcode of the or of each applicant (underline all surnames)

1... Limited

St John's Innovation Centre
Cowley Road
Cambridge CB4 0WS

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

England

8110870001

4. Title of the invention

LOUDSPEAKER

5. Name of your agent (if you have one)

Ursula Lenel

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

1... Limited

St John's Innovation Centre
Cowley Road
Cambridge CB4 0WS

Patents ADP number (if you know it)

8110870001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number
(if you know it)Date of filing
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

YES

- a) any applicant named in part 3 is not an inventor, or
- b) there is an inventor who is not named as an applicant, or
- c) any named applicant is a corporate body.

See note (d))

Patents Form 1/77

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	5
Claim(s)	1
Abstract	1
Drawing(s)	2

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 8/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11.

I/We request the grant of a patent on the basis of this application.

Signature

Ursula Lenei

Date 17-NOV-2003

12. Name and daytime telephone number of person to contact in the United Kingdom

Ursula Lenei

01223-422290

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Notes

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LOUDSPEAKER

FIELD OF THE INVENTION

This invention relates to a loudspeaker for use in a possibly portable electronic device such as a mobile phone, Personal Digital Assistant (PDA) or lap-top computer.

BACKGROUND OF THE INVENTION

10 A compact loudspeaker technology that allows a panel in the casework of electronic products to be driven as a speaker is described in the commonly owned international patent application number WO-03001841. A preferred embodiment, known as the C-window, comprises a
15 transparent panel driven as the sound generating element (diaphragm) of a loudspeaker by a piezoelectric actuator, in which the motion of the sound generating element includes an element of rotation about an axis parallel to the diaphragm. An actuator in the form of a cylinder
20 with a sector removed, that is, with a cross-section approximating to the shape of the letter C, is described.

The C-shaped actuator is of piezoelectric bender construction. One end (one arm of the 'C') is mounted to
25 the casework while the other end (the other arm of the 'C') is mounted to the diaphragm. On activation with an appropriate signal the case-mounted end is relatively fixed while the diaphragm-mounted end moves, the motion approximating to rotation about the axis of the 'C'.
30 This motion is transmitted to the diaphragm, whose motion therefore also includes an element of rotation about the axis of the 'C', thereby generating sound.

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A further improvement to the C-window is described in the commonly owned British patent application GB 0324051.2, in which both ends of the C-shaped actuator are mounted to different parts of the diaphragm, facilitating
5 manufacture. In this case, the speaker can be manufactured as a self-contained unit which can then be simply incorporated into the casework in a subsequent manufacturing step.

10 It is the purpose of the present invention to provide improved (greater) levels of sound in compact speakers such as those described above.

SUMMARY OF THE INVENTION

15

Accordingly, in a first aspect the present invention provides a loudspeaker comprising a sound generating element and two actuators mounted at opposing edges of the sound generating element, the motion of said
20 actuators including an element of rotation about an axis parallel to the sound generating element.

Each actuator is mounted at an edge of the sound generating element. The two actuators are at opposing
25 ends of the sound generating element and are preferably activated with identical signals, such that both ends of the diaphragm are driven in concert, that is both ends move up, for example, at the same time. Each actuator may be comprised of a number of actuator elements. Both
30 ends of the diaphragm move with some element of rotation, the rotations being in opposition. The diaphragm is designed to be sufficiently flexible to allow these opposing rotations. That is, the material and dimensions of the diaphragm are selected to provide an appropriate

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level of stiffness such that the diaphragm is stiff enough to effectively move the adjacent air to create sound, and flexible enough to allow its opposed ends to be contra-rotated.

5

In a preferred embodiment, each actuator comprises a single element of piezoelectric bender construction shaped as a cylinder with a sector removed.

10 One end of each actuator is mounted to the diaphragm. The other end of each actuator may be mounted directly to the casework, or alternatively it may be mounted to another portion of the diaphragm.

15 The provision of drive at each end of the diaphragm allows a greater sound pressure to be produced from a given area of diaphragm than if the diaphragm were driven at one end alone.

20 These and other aspects of the invention will be apparent from the following detailed description of non-limitative examples making reference to the following drawings.

25

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS 1A and 1B (Prior Art) show a known compact speaker, FIG 1A in perspective view and FIG 1B in cross-section;

FIG 2A and 2B show an example of the speaker of the invention, FIG 2A in perspective view and FIG
30 2B in cross-section, illustrating the motion of the diaphragm.

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DETAILED DESCRIPTION

FIG 1A shows a perspective view of a known compact speaker as described in WO-03001841. It shows a section of the case 11 and the diaphragm 12 in the vicinity of the actuator 13. The actuator 13 comprises a tubular element 14 of electro-active material. An approximately 90 degree section of the tubular element parallel to its main axis is removed, giving the element 14 an approximately C shaped cross-section. The case 11 is fixed to a first edge 41 of the tubular element 14, whereas the sound generating element or diaphragm 12 is attached to a second edge 42 of the tubular element 14. FIG 1B is a schematic cross-section illustrating the movement of the known speaker of FIG 1A. The actuator 13 deforms rotationally when activated, lifting the diaphragm 12 to the position shown by the dashed line 122. The distal end 121 moves upwards to the position 123. The rotation element of the motion of the diaphragm is illustrated by the arrow.

FIG 2A shows a perspective view of an example of the present invention. A diaphragm 12 and two sections of the case 11 are shown. Two actuators 21 and 22 are shown, one at each end of the diaphragm 12. Each actuator 21, 22 is mounted to both the case 11 and the diaphragm 12. FIG 2B illustrates schematically the movement of the diaphragm 12 on actuation. The position of the diaphragm 12 on activation of the actuators 21, 22 is shown by the dashed line 124. The provision of two actuators 21, 22 enhances the sound output in comparison with the known device of FIG 1.

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It will be apparent that other forms of actuator, other shapes of diaphragm and other methods of mounting fall within the scope of the present invention.

- 5 -

- 6 -

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CLAIMS

1. A loudspeaker comprising a sound generating element
and two actuators mounted at opposing edges of the
5 sound generating element, the motion of said
actuators including an element of rotation about an
axis parallel to the sound generating element.

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ABSTRACT

A loudspeaker for a portable electronic device such as
a mobile phone comprising a sound generating element
5 driven by two piezoelectric actuators disposed at two
opposing edges of the sound generating element. The
motion of the actuators includes an element of rotation
about an axis parallel to the sound generating element.
The speaker produces a greater sound output than a
10 speaker driven at one end only.

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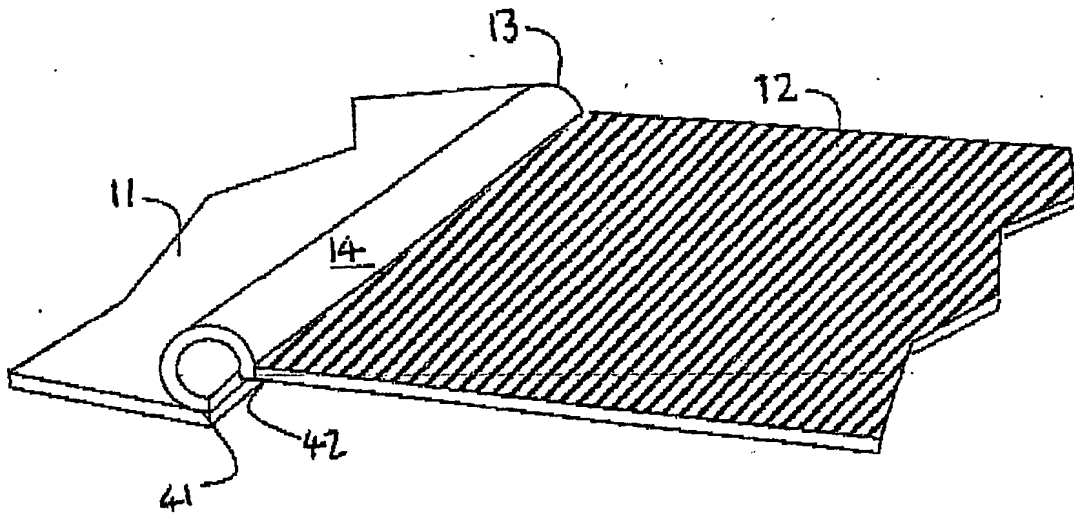


FIG. 1A

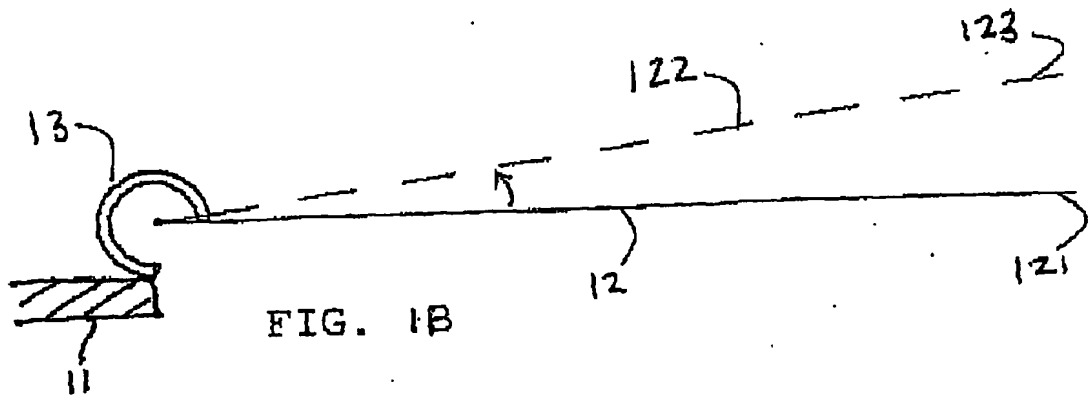


FIG. 1B

P177-9B

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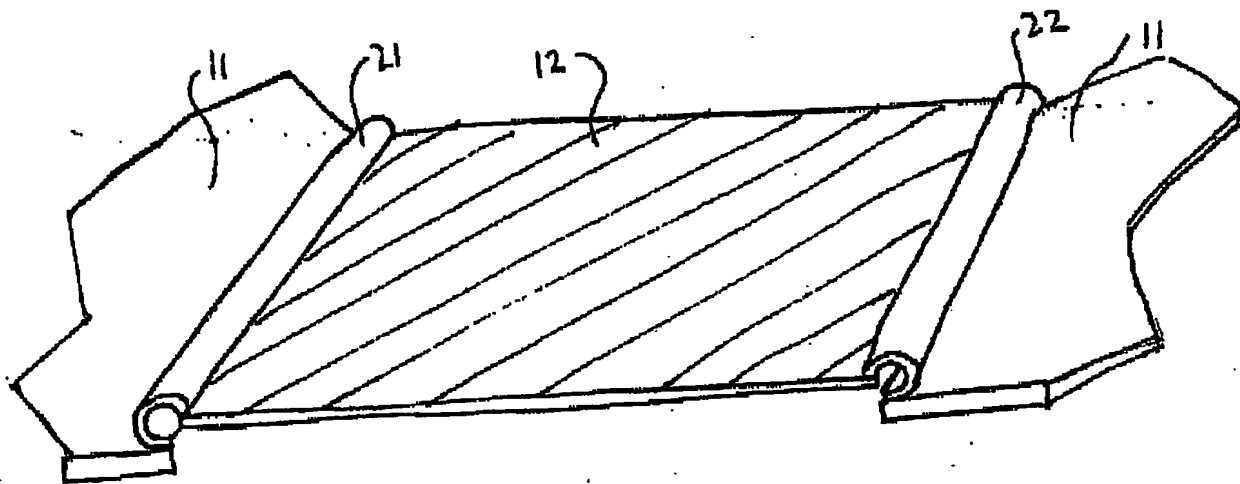


FIG. 2A

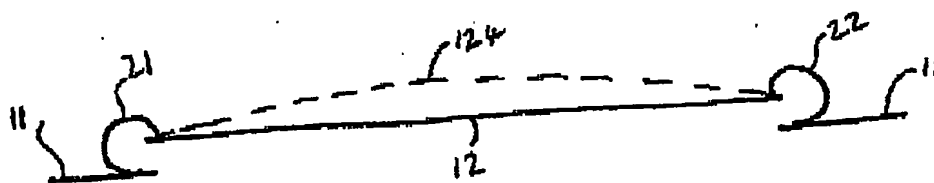


FIG. 2B

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